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National Qualifications 2022 MODIFIED

Mark

# X816/76/01 Computing Science

MONDAY, 30 MAY
1:30 PM – 3:30 PM

*X8167601*

**Fill in these boxes and read what is printed below.**

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth
Day Month Year

Scottish candidate number

**Total marks — 80**

**SECTION 1 — Software design and development, and Computer systems — 55 marks**
Attempt ALL questions.

**Attempt EITHER Section 2 OR Section 3**

**SECTION 2 — Database design and development — 25 marks**

**SECTION 3 — Web design and development — 25 marks**

**You may use a calculator.**
Show all workings.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.



*X8167601 01*

## SECTION 1 — SOFTWARE DESIGN AND DEVELOPMENT, AND COMPUTER SYSTEMS — 55 marks

**Attempt ALL questions**

**1.** Two's complement can be used to represent positive and negative integers.

State the range of denary values that can be represented using 32-bit two's complement. **2**

**2.** Write the following binary number using floating-point representation.

−111 0000 1111.0101

There are 16 bits for the mantissa (including the sign bit) and 8 bits for the exponent. **3**

*Space for working*

| sign | mantissa | exponent |
|---|---|---|
| | | |

**3.** LottoScot has a logo shown below in diagram 1. They want to change the logo to the one in diagram 2.


**Diagram 1**


**Diagram 2**

In diagram 2 the rectangle has been moved forward.

Explain the advantage of making this change using a vector graphic application compared to a bit-mapped graphic application. **2**

**4.** Explain why a processor with larger cache would outperform an identical processor with smaller cache. **2**

**[Turn over**

**5.** A mathematician has written a program to generate the first six numbers in a mathematical sequence. The next number in the sequence is the sum of the previous two numbers. For example, if the sequence starts with

5,7, . . .

Then the first six numbers of the sequence would be

5, 7, 12, 19, 31, 50

The following code has been developed to generate the sequence of six numbers.

```
...
Line 10  DECLARE sequence INITIALLY [0,0,0,0,0,0]
Line 11  SET sequence[0] TO 5
Line 12  SET sequence[1] TO 7
Line 13  FOR n FROM 2 TO 5 DO
Line 14       SET sequence[n] TO sequence[n] + sequence[n-1]
Line 15  END FOR
...
```

(a) A logic error in the code means that an incorrect sequence is generated. The trace table below shows the line numbers where a variable has changed.

| Line Number | sequence | n |
|---|---|---|
| 10 | [0,0,0,0,0,0] | |
| 11 | [5,0,0,0,0,0] | |
| 12 | **A** | |
| 13 | | 2 |
| 14 | **B** | |
| 13 | | 3 |
| 14 | **C** | |

State the missing values at **A**, **B** and **C**. **3**

**A** _____

**B** _____

**C** _____

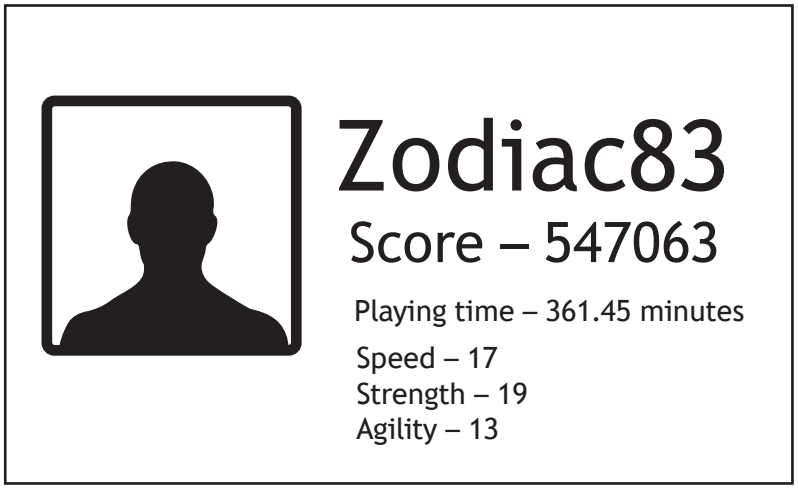
**5. (continued)**

(b) Re-write Line 14 of the code to generate the correct sequence. **2**

**[Turn over**

DO NOT WRITE IN THIS MARGIN

**6.** An online game stores a player's unique ID, their total score and the number of minutes they have played the game. The game also stores three attributes for the player which are speed, strength and agility.



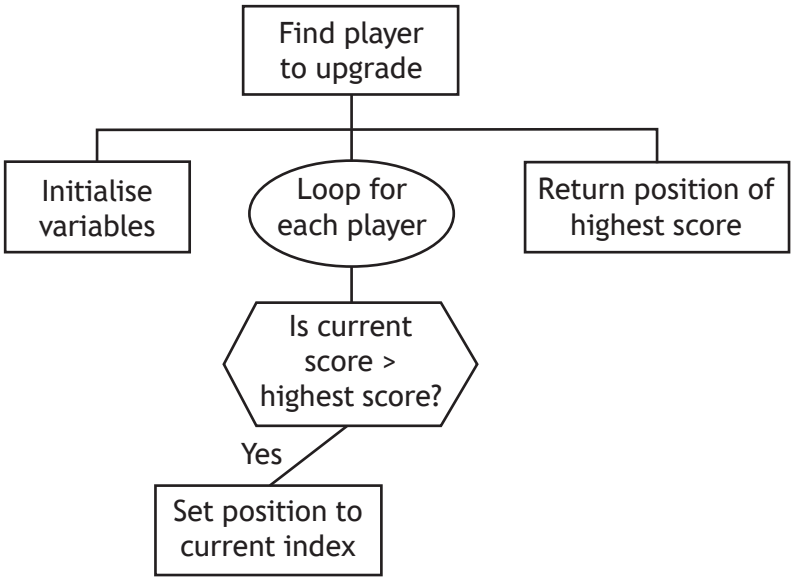

Throughout gameplay the player's score and playing time are updated.

**6. (continued)**

(a) At the end of each week, the player with the highest score is rewarded with an upgrade to one of their three attributes.

If more than one player has the same score, then the player who has been playing for the shortest time is rewarded.

The design for this part of the program is shown below.




Explain why a program produced from this design would not be fit for purpose. **1**

MARKS

DO NOT WRITE IN THIS MARGIN

(b) The game stores the following details for each player:

- unique ID
- score
- the number of minutes they have played the game
- speed
- strength
- agility.

A sample of data is shown below.

```
...
Zodiac83, 547063, 361.45, 17, 19, 13
Thrasher05, 176491, 175.12, 15, 25, 14
Knuckles45, 92543, 63.42, 16, 14, 21
...
```

(i) Using a programming language of your choice, define a suitable record data structure to store the data. **2**

(ii) There are currently 10 000 registered players in the game.

Using a programming language of your choice, declare a variable that can store the data for the 10 000 players. Your answer should include the record data structure defined in part (i). **2**

**6. (continued)**

(c) All players whose playing time is over 500 minutes will have their speed increased by 3.

Using a programming language of your choice, write the code to implement this. Your answer should use the record data structure from part (b) (i). **4**

**6. (continued)**

(d) The program is implemented using sub-programs to help to make the code maintainable.

Describe two other benefits of creating modular code. **2**

(e) As part of the program's comprehensive test plan each sub-program was tested individually.

Describe one benefit of having a comprehensive test plan. **1**

**7.** An app can be used to record two players' scores on a 9 hole mini-golf course.

A player wins a hole if they have fewer shots than their opponent. For example, Claire has won the first hole taking only two shots compared to Tina's four shots.

After nine holes, Claire has won four holes and Tina has won two.


Both players' names and their nine scores are entered.

The app displays the name of the player who wins the most holes or a message stating the game has been drawn if the number of holes won is the same.

(a) One boundary of this app is that the app is for games between exactly two players.

State two other boundaries for this app. **2**

_____

_____

_____

_____

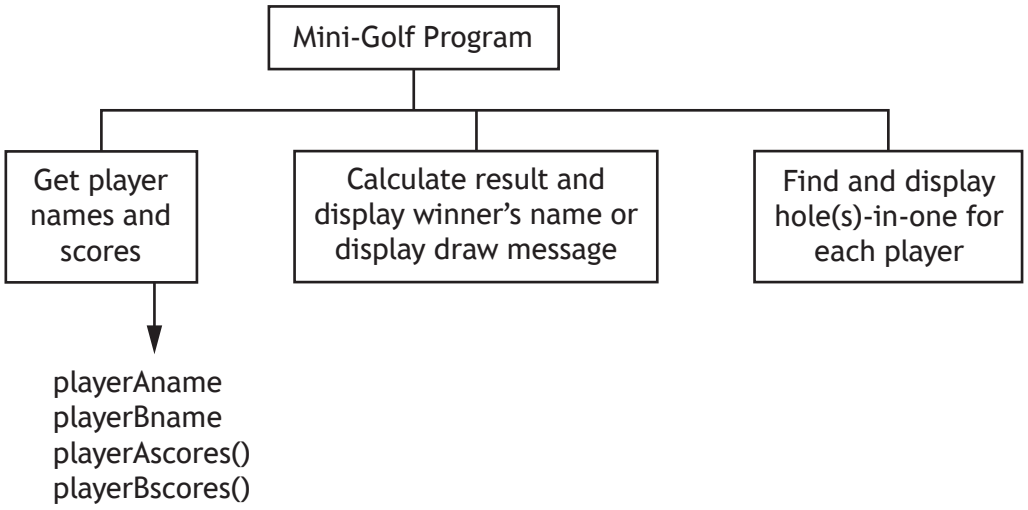
_____

**[Turn over**

**7. (continued)**

(b) The top-level design of the main steps of the program is shown below.

Complete the diagram to show the data flow for the program. **2**



**7. (continued)**

(c) Using a design technique of your choice, refine the following step. **6**

Calculate result and display winner's name or display draw message

**7. (continued)**

(d) A hole-in-one is achieved when a player completes the hole by taking just one shot.

The app counts and displays the number of holes-in-one for a player. Below is the code used to implement this feature. When tested the code was found to contain errors.

```
...
Line 201  FUNCTION holesInOne (ARRAY OF INTEGER scores)
          RETURNS INTEGER
Line 202      DECLARE noHolesInOne INITIALLY 0

Line 203      FOR index FROM 0 TO 8 DO
Line 204          IF scores[index] = 1 THEN
Line 205              SET noHolesInOne TO noHolesInOne + 1
Line 206          END IF
Line 207      END FOR

Line 208      RETURN noHolesInOne
Line 209  END FUNCTION
...
Line 258  SEND playerAname & " has scored " &
          holesInOne(playerAname, playerAscores) &
          " hole(s)-in-one" TO DISPLAY
...
```

(i) There is an error at the function call.

Describe the error. **1**

(ii) Using a programming language of your choice, correct the error described in part (i). **1**

**7. (continued)**

(e) Programmers have control over the scope of a variable when writing code.

Describe how the position of the declaration of a variable, within code, determines its scope. **2**

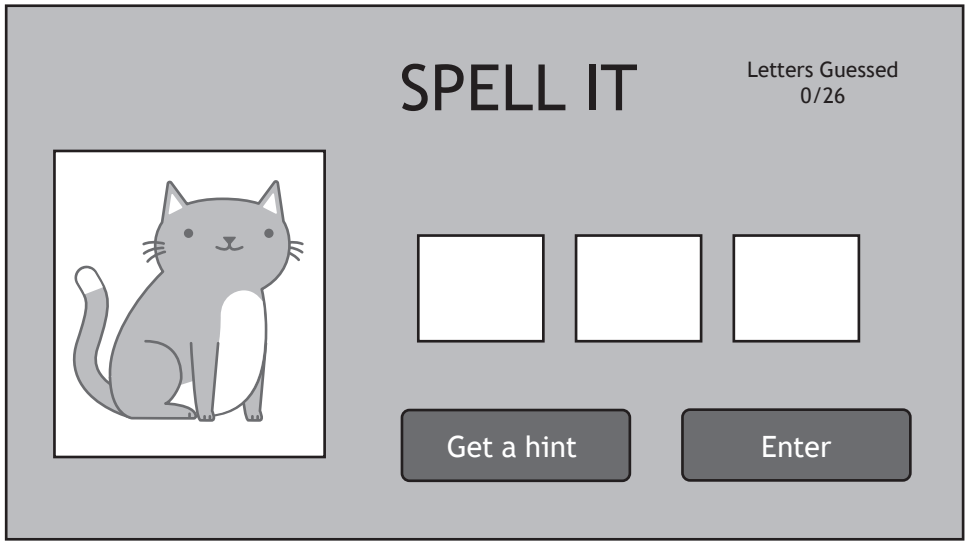
**[Turn over**

**8.** A game displays a picture and the user is asked to spell the matching word by entering letters.

When a correct letter is entered by the user the letter is filled into the correct box(es).

The game displays the number of letters that the user has already guessed.

The user is able to get a hint. Once the correct letters have been entered a message of congratulations is displayed.




(a) Describe two processes of this game. **2**

Process 1 _____

_____

Process 2 _____

_____

**8. (continued)** **MARKS** DO NOT WRITE IN THIS MARGIN

(b) The first level of the game uses words that are three letters long. These words are stored in a text file called `threeLetters.txt`.

Using a design technique of your choice, design a program to read in this file, pick one of the words at random and assign it to a variable called `chosenWord`. **4**

(c) As the game progresses the words get longer and users can get hints from the game.

Using a programming language of your choice, write code to:

(i) assign the variable `hintOne` the first letter of the word stored in the `chosenWord` variable. **1**

(ii) assign the variable `hintTwo` a random letter from the word stored in the `chosenWord` variable. **2**

**8. (continued)**

**MARKS** DO NOT WRITE IN THIS MARGIN

(d) When the user enters a letter they have not already chosen, this is stored in an array called `usedLetters`. The number of letters stored in the array is increased by one and is stored in a variable called `numLetters`.

For example:

| | **Values** |
|---|---|
| `usedLetters` | `["D", "Z", "R", "B", "", "", "", "", "", "", "", "", "", "", "", "", "", "", "", "", "", "", ""]` |
| `numLetters` | `4` |

If the user enters a letter already stored in the array `usedLetters` an error message is displayed. The user is asked to try again until they enter a letter that is not already stored in this array.

Using a programming language of your choice, write the code to implement this feature. **6**

**[END OF SECTION 1]**

## SECTION 2 — DATABASE DESIGN AND DEVELOPMENT — 25 marks

**Attempt ALL questions**

MARKS | DO NOT WRITE IN THIS MARGIN

**9.** Cara runs a private tutoring company for Computing Science students.

Cara requires a relational database to:

- store data on students, tutors and sessions
- display the contact details for a particular tutor or student
- display the number of sessions for a particular date
- display the total fees that each tutor has been paid
- display the tutor who charges the lowest hourly rate.

(a) State one functional requirement of the relational database. **1**

(b) Cara has created a relational database that uses three tables.

| **Student** | **Tutor** | **Session** |
|---|---|---|
| studentID | tutorID | sessionID |
| studentName | tutorName | sessionDate |
| studentAddress | tutorAddress | sessionTime |
| studentContactNo | tutorContactNo | duration |
| | hourlyRate | tutorID* |
| | | studentID* |

Draw an entity-relationship diagram to show the relationships that exist in this database.

Your answer should show the entity names and cardinality. Attributes are not required on the diagram. **2**

DO NOT WRITE IN THIS MARGIN

**10.** A swimming club uses a database to store details of swimmers and their times in a 50 metres swim. A sample of the data stored in the `Swimmer` table is shown below.

| **Swimmer** | | | |
|---|---|---|---|
| **swimmerNo** | **swimmer** | **squad** | **time** |
| 001 | M Marston | Dolphins1A | 30.25 |
| 002 | S Cochrane | Dolphins2A | 25.75 |
| 003 | L Richards | Dolphins1B | 30.23 |
| 004 | F Qazi | Dolphins2A | 35.45 |
| 005 | R Mirza | Dolphins1A | 28.15 |
| 006 | J Smith | Sharks1A | 29.35 |
| 007 | L Pascal | Sharks2A | 32.25 |
| 008 | F McDonald | Sharks1B | 31.45 |
| 009 | T Madison | Sharks2B | 36.54 |
| 010 | M Johnston | Sharks1B | 39.15 |
| 011 | M Davidson | Sharks1A | 29.45 |
| 012 | Z Habib | Dolphins1A | 25.45 |
| 013 | K Patel | Sharks1B | 33.76 |
| … | … | … | … |

**10. (continued)**

The head coach would like to produce a report displaying the slowest and fastest times from any of the squads with a '1' in their name, as shown below.

| squad | Slowest Time | Fastest Time |
|---|---|---|
| Dolphins1A | 30.25 | 25.45 |
| Dolphins1B | 30.23 | 30.23 |
| Sharks1A | 29.45 | 29.35 |
| Sharks1B | 39.15 | 31.45 |

The following SQL statement is executed.

```
SELECT squad, MIN(time) AS [Slowest Time], MAX(time) AS
[Fastest Time]
FROM Swimmer
WHERE squad LIKE "1"
```

When tested, the actual output did not match the expected output.

Identify the three errors in the above SQL statement. **3**

Error 1 _____

_____

Error 2 _____

_____

Error 3 _____

_____

**[Turn over**

DO NOT WRITE IN THIS MARGIN

**11.** Perfect Eyes is an optician that has branches throughout Scotland. It uses a relational database consisting of three linked tables to store data about customers, opticians and specialist referrals.

Extracts from the three tables are shown below.

| **Customer** | | | | | | |
|---|---|---|---|---|---|---|
| **customerID** | **opticianID** | **forename** | **surname** | **loyaltyPoints** | **address** | **town** |
| AW3212 | KM101 | Amy | Wilson | 24 | 8 Pelken Road | Paisley |
| JP2323 | CS878 | Joyce | Peden | 47 | 42 Bewston Road | Ayr |
| JS9767 | KM101 | Julia | Smith | 77 | 32 Bracken Road | Paisley |
| KC1123 | MS221 | Katy | Carenduff | 11 | 12 Main Street | Melrose |
| LL3234 | CS878 | Robin | Li | 51 | 21 Manse Court | Largs |
| MR8766 | JS232 | Margaret | Rennie | 73 | 63 Royal Crescent | Dalry |
| SR7123 | CS878 | Steven | Rycroft | 50 | 22 Markston Place | Ayr |
| … | … | … | … | … | … | … |

| **Optician** | | | |
|---|---|---|---|
| **opticianID** | **opticianName** | **opticianAddress** | **opticianTown** |
| KM101 | Mr K Madhok | South Road | Paisley |
| KM321 | Mr M Ali | Main Road | Troon |
| MS221 | Mrs M Saunders | St Dunstan's Park | Melrose |
| … | … | … | … |

| **Referral** | | | |
|---|---|---|---|
| **referralID** | **customerID** | **referralDate** | **specialist** |
| P12121 | AW3212 | 12/02/2022 | Gerard McGowan Eye Clinic |
| H92743 | HS3433 | 14/02/2022 | JK Optometrist |
| CXR222 | JP2323 | 28/04/2022 | Eye Clinic at Newmains |
| U32349 | JS9767 | 26/04/2022 | Gerard McGowan Eye Clinic |
| … | … | … | … |

**11. (continued)**

A query is required to list customers who were referred in April 2022 to any specialist that includes 'Eye Clinic' in its name. The list should be displayed with the most recent referral date first, as shown below.

| **forename** | **surname** | **referralDate** | **specialist** |
|---|---|---|---|
| Joyce | Peden | 28/04/2022 | Eye Clinic at Newmains |
| Julia | Smith | 26/04/2022 | Gerard McGowan Eye Clinic |
| Margaret | Rennie | 01/04/2022 | University Hospital Eye Clinic |

(a) Complete the design of a query to produce this output. **3**

| | |
|---|---|
| Field(s) and calculation(s) | forename, surname, referralDate, specialist |
| Tables(s) | |
| Search criteria | |
| Grouping | |
| Sort order | referralDate DESC |

**[Turn over**

**11. (continued)**

(b) Perfect Eyes wants to know which customers have more than the average loyalty points.

(i) Write the SQL statement to display the average loyalty points of the customers, as shown below. **2**

| Average Points |
|---|
| 38.4 |

(ii) The query from part (i) is saved as 'AvgPointsQuery'. Using this query, complete the SQL statement to display the customers who have more than the average loyalty points, in order from highest to lowest as shown below. **4**

| forename | surname | loyaltyPoints | opticianName |
|---|---|---|---|
| Julia | Smith | 77 | Mr K Madhok |
| Margaret | Rennie | 73 | Mr M Ali |
| Robin | Li | 51 | Miss C Srigor |
| Steven | Rycroft | 50 | Miss C Srigor |
| … | … | … | … |

```
SELECT forename, surname, loyaltyPoints, opticianName
```

**12.** A car dealership uses a relational database to store the following information in three tables as shown below.

| CarSale | Customer | SalesPerson |
|---|---|---|
| saleID<br>carReg<br>dateIn<br>year<br>mileage<br>askingPrice<br>sold<br>dateSold<br>salesPersonRef*<br>customerNo*<br>soldPrice | customerNo<br>firstName<br>surname<br>contactNo | salesPersonRef<br>salesPersonName |

(a) When the `CarSale` table was originally designed, it was suggested that a compound key could have been used.

Explain why a compound key would not have been suitable for the `CarSale` table. **1**

(b) Sample data from the `CarSale` table is shown below.

| CarSale | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **saleID** | **carReg** | **dateIn** | **year** | **mileage** | **askingPrice** | **sold** | **dateSold** | **salesPersonRef** | **custNo** | **soldPrice** |
| 001 | KS17 SDD | 17/07/2019 | 2017 | 2400 | 15305 | Yes | 19/09/2019 | GA001 | 1234 | 14000 |
| 002 | DD15 LDX | 11/10/2019 | 2015 | 45512 | 6000 | Yes | 22/11/2019 | AJ344 | 1234 | 5750 |
| 003 | DG15 KJS | 01/03/2021 | 2015 | 34069 | 5000 | Yes | 26/06/2021 | AJ344 | 7001 | 4800 |
| 004 | KS19 AZX | 14/08/2021 | 2019 | 10033 | 13655 | Yes | 19/09/2021 | AJ344 | 7747 | 13555 |
| 005 | FF18 PMD | 08/12/2021 | 2019 | 8238 | 10800 | Yes | 28/12/2021 | SS002 | 5414 | 10500 |
| 006 | LK16 JSS | 07/03/2022 | 2016 | 45300 | 8500 | No | | | | |
| 007 | EF18 FES | 10/03/2022 | 2018 | 29178 | 11709 | No | | | | |
| 008 | DD15 LDX | 15/03/2022 | 2015 | 72130 | 5000 | No | | | | |
| 009 | KP15 DDS | 01/04/2022 | 2015 | 34444 | 7900 | Yes | 02/05/2022 | GA001 | 3002 | 7800 |
| 010 | KS17 SDD | 01/04/2022 | 2017 | 22452 | 12000 | No | | | | |
| 011 | PK17 YFK | 22/04/2022 | 2017 | 19858 | 22663 | No | | | | |
| 012 | FF17 EES | 26/04/2022 | 2017 | 14469 | 10166 | No | | | | |
| 013 | DS17 KRF | 02/05/2022 | 2017 | 16113 | 14748 | No | | | | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

A customer would like to buy a car from the years 2017 or 2018. They want to know the cheapest asking price of the 2017 and the 2018 cars that are currently on sale.

This information is shown below.

| year | Cheapest Price |
|---|---|
| 2017 | 10166 |
| 2018 | 11709 |

Complete the design of a query that will display the information as shown above. **3**

| Field(s) and calculation(s) | |
|---|---|
| Tables(s) | CarSale |
| Search criteria | |
| Grouping | |
| Sort order | year ASC |

(c) The manager would like to display a list of all cars that have been sold, showing the price difference between the asking price and the sold price.

The list should look like this.

| carReg | salesPersonName | askingPrice | soldPrice | Price Difference |
|---|---|---|---|---|
| KP15 DDS | Daniel Avery | 7900 | 7800 | 100 |
| FF18 PMD | Deanna Smith | 10800 | 10500 | 300 |
| KS19 AZX | Hosea Jack | 13655 | 13555 | 100 |
| DD15 LDX | Hosea Jack | 6000 | 5750 | 250 |
| DG15 KJS | Hosea Jack | 5000 | 4800 | 200 |
| KS17 SDD | Daniel Avery | 15305 | 14000 | 1305 |
| … | … | … | … | … |

Write the SQL statement that would create this list. **4**

(d) The asking price of all cars with mileage of 10 000 or less have to be increased by 10%.

Write the SQL statement that would make these changes. **2**

**[END OF SECTION 2]**

**[BLANK PAGE]**

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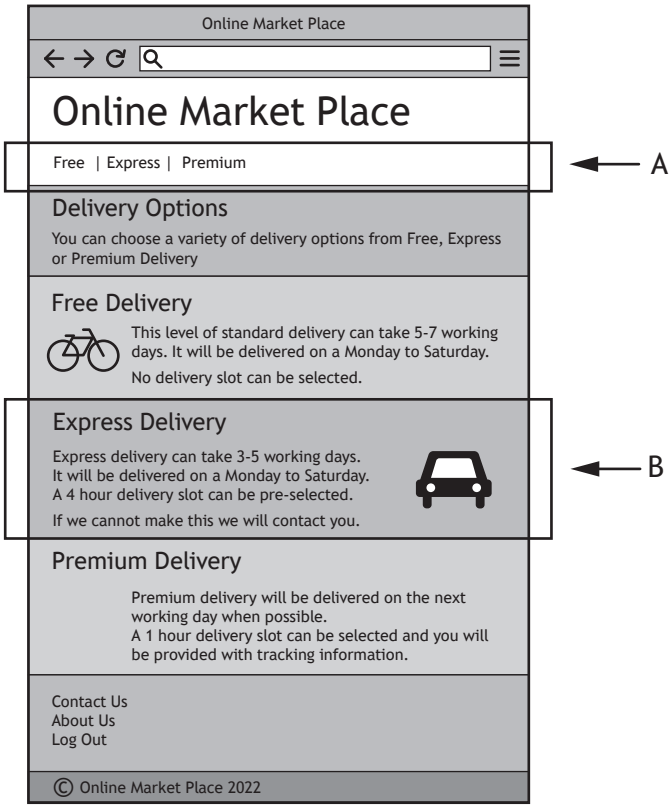
## SECTION 3 — WEB DESIGN AND DEVELOPMENT — 25 marks

**Attempt ALL questions**

**13.** HTML 5 elements have been used to define different parts of a web page shown below.




State which elements should be used for the parts labelled A and B. **2**

A _____

B _____

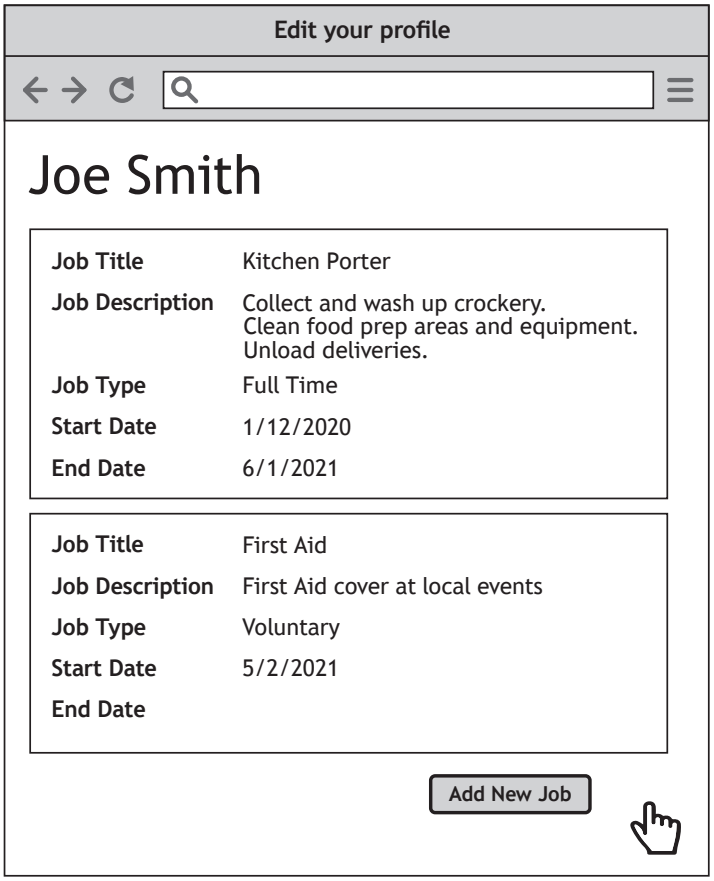
**[Turn over**

DO NOT WRITE IN THIS MARGIN

**14.** A recruitment agency website allows users to create a profile to detail their employment history.

Once logged in users can update their employment history by adding the following pieces of compulsory information: job title, job description, job type (full time, part time or voluntary) and start date. An end date should only be provided when they have left that job.

An example of the 'Edit your profile' page is shown below.



**14. (continued)**

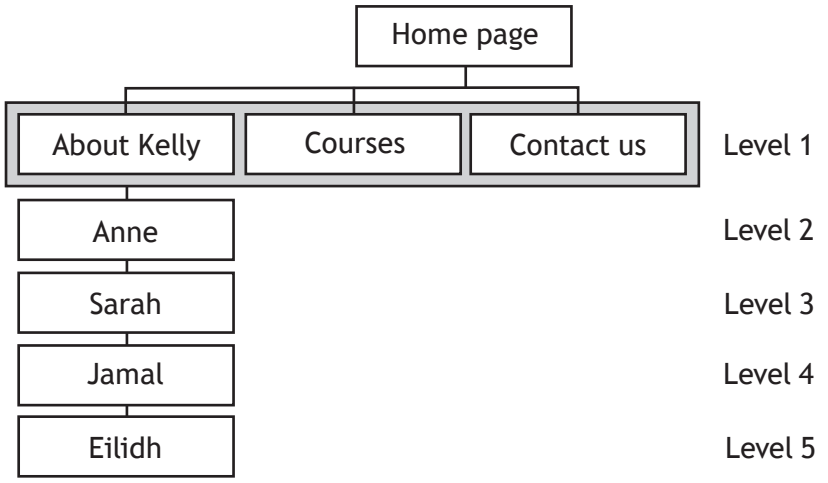
Draw a wireframe for a form that would allow users to provide the information for a new job. **4**

**[Turn over**

**15.** Kelly runs a company offering driving lessons.

She wants a website where users can view her profile page and from there directly access individual pages about each of her instructors: Anne, Sarah, Jamal and Eilidh. The website should also detail the courses offered, a frequently asked questions page and a page where users can contact the company.

The multi-level structure below was proposed.




(a) Explain why this structure did not meet the requirements. **2**

**15. (continued)**

(b) The developers proposed an initial design for the 'Contact us' page.
The design is shown below.


A low fidelity prototype was created from the wireframe above.
State two issues that should be identified from usability testing. **2**

_____

_____

_____

_____

_____

_____

**[Turn over**

**15. (continued)**

(c) The style rule for `h1` headings is shown below.

```
h1 { font-family: Verdana;
     text-align: center;}
```

All `h2` and `h3` elements should also be formatted using the rule above. All `h2` elements should also have a 10 pixel padding.

Making use of a grouping selector where appropriate, write the CSS rules to format the headings. **2**

**15. (continued)**

(d) On the 'Courses' page there are a large number of different course packages that are offered. A sample of the HTML code used to implement this page is shown below.

```
<h1>We offer varying courses including:</h1>
<ul>
     <li>Beginners</li>
     <li>Refresher</li>
</ul>

<h2>Course Details</h2>
<ol>
     <li>Beginners Course</li>
     <ul>
          <li>Cost: £30 per lesson</li>
          <li>Minimum Lessons: 2</li>
          <li>Lesson Length: 1hr</li>
     </ul>
     <li>Refresher Course</li>
     <ul>
          <li>Cost: £25 per lesson</li>
          <li>Minimum Lessons: 1</li>
          <li>Lesson Length: 1.5 hr</li>
     </ul>
</ol>
```

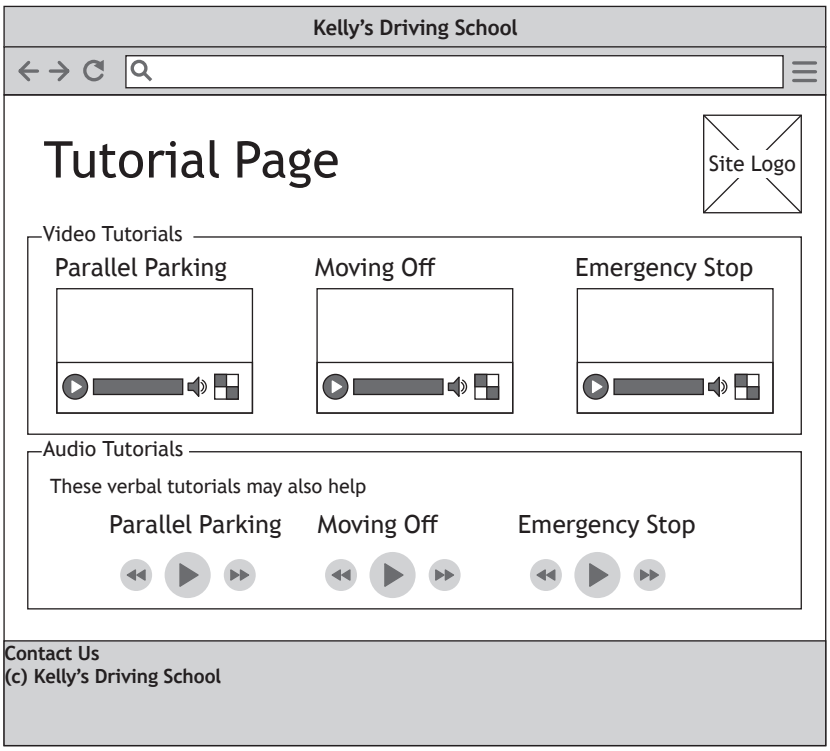
The CSS rules shown below are used to style the 'Courses' page.

```
ul { color: yellow ; }
ol ul li { color: blue ; }
```

Describe the effect of these CSS rules on this page. **2**

**15. (continued)**

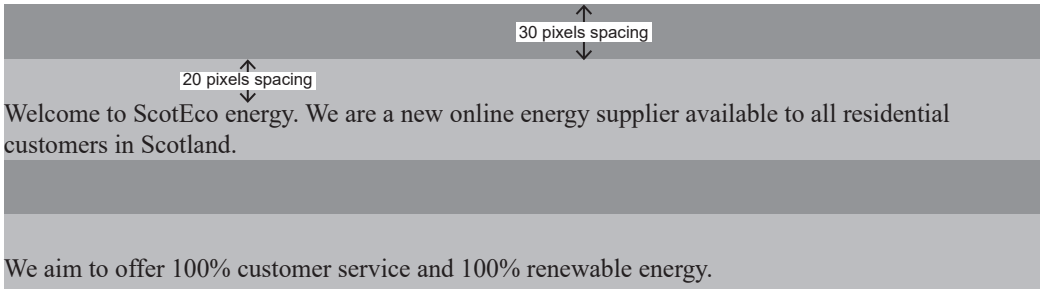
(e) Kelly wants to add a tutorial page with videos and audio clips as shown in the wireframe below.




State two different compatibility tests that should be carried out on this page. **2**

**16.** An energy supplier's website allows customers to log in and manage their account online.

(a) They are redesigning their home page and want to implement the spacings shown below.




Using the partially completed code below, complete the CSS rules to implement the appropriate spacing as shown above. **2**

```
<style>
   main { background-color: darkgrey;}
   p { background-color: lightgrey;

   _____________________________________________________ ;

   _____________________________________________________ ;}
</style>

<main>
   <p>Welcome to ScotEco energy. We are a new online
   energy supplier available to all residential
   customers in Scotland</p>

   <p>We aim to offer 100% customer service and 100%
   renewable energy.</p>
…
```

**[Turn over**

**16. (continued)**

(b) A navigation bar will be included across the site.


Complete the CSS rule that will change the colours to black and white if the cursor moves over a link. **2**

```
nav { height:40px; }
nav ul li { float:left;width:100px;text-align:center; }
nav ul li a { display:block;padding:10px; }

nav ul li _____{ _____;

_____; }
```

(c) One of the web pages uses multiple div elements as shown below.

```
<p>Tariff one</p>
<p>Tariff two</p>
<p>Tariff three</p>
```

They are to be displayed as shown below.

| Tariff one | Tariff two | Tariff three |
|---|---|---|

The CSS rule below is added.

```
p { display: inline ;}
```

Explain why this CSS rule displays the contents of the elements side by side. **1**

_____

_____

_____

_____

_____

**16. (continued)**

(d) When an image, 'question.jpg', on the web page is clicked, it should display the text:

'For more help call us on 0800 300200'

The JavaScript code below does not correctly implement this feature.

```
<script>
  function displayHelp(){
      document.getElementById("display").style.display="block";
  }
</script>

<p>For help please click on the icon below.</p>

<img src="question.jpg" >

<div id="help" style="display:none">

    <p>For more help call us on 0800 300200</p>
</div>
…
```

(i) Re-write the line of code which will use a JavaScript event to call the function `displayHelp` when the image 'question.jpg' is clicked. **2**

(ii) Explain why the text is still not displayed when the function `displayHelp` is called. **1**

**16. (continued)**

All customers have electricity meters and some customers also have a gas meter.

The HTML code below allows the user to enter their meter readings.

```
…
<form>
…

    Electricity Meter Reading <br>
    <input type="number" name="electricity">

    Gas Meter Reading <br>
    <input type="number" name="gas">

    <input type="submit">
…
</form>
…
```

(e) Re-write the line of HTML code to ensure that a reading has been entered for the electricity meter. **1**

**[END OF SECTION 3]**

**[END OF QUESTION PAPER]**

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